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1985/08/02

V. M. Malhotra
Head, Construction Materials Section
CANMET
405 Rochester Street
Ottawa, Ontario
K1A OG1

Re: Date for Contract ØST 83-00418 "Creep of Concrete Containing Fly Ash", DSS File #24 ST. 23440-4-9013

Enclosed are the results of creep tests on thirteen sets of specimens supplied by EMR between May and September 1985 and loaded for a period of one year.

The only anomalies apparent in the data which may require explanation are as follows:

(i) Some readings scheduled in February 1985, were not taken because of illness of my research assistant. However, there are more than enough readings before and after to establish the trend of the data.

(ii) A breakdown of humidity control occurred sometime in the latter part of May 1985 when the humidity rose from the required 50% to much higher values for several days. This was due to a defective solenoid in the humidifier which was subsequently repaired. The effect can be clearly seen in the strain readings marked * which were taken subsequently, and the corresponding creep data should be interpreted accordingly. Nevertheless, there is enough data taken prior to the breakdown to establish the creep-time relationship.

In reporting the data, I started by recopying all the raw data for each specimen in a set of four, and then preparing a summary sheet reporting creep strain computed according to ASTMC512. However, this proved excessively time-consuming, and in the remainder of the tests the raw data is not recopied. Instead, the original pencilled data sheets are appended to the summary sheet which is prepared in inked form. Data yet to be obtained up to one year for some of the tests will be forwarded when available.

I hope you find the new format used for reporting the data satisfactory. If you wish to suggest modifications, please do so before the next set of tests commences.

Yours sincerely,

C. D. Johnston
Professor of Civil Engineering

c.c. Bob Martin
CDJ/ps
Encls.

14 pp.

OCT 30 1985
MICROMEDIA

CREEP DATA REPORT (ASTM C512)

Mix Designation CA Date of Mixing FEB. 7/84

Specimen Number CA 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading MAY 8/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 269 με Instantaneous Modulus 37.2 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAIN-με

Date		CA-3 LOADED	CA-4 LOADED	CA-5 UNLOADED	CA-6 UNLOADED	CREEP STRAIN-με			
MAY 8/84	0	267	270			0			
"	4-6 hrs	317	320						
9/84	1	387	370	7	13	100			
10/84	2	417	393	13	20	120			
11/84	3	440	417	27	33	130			
14/84	6	497	477	50	57	165			
16/84	8	547	510	57	63	200			
22/84	14	610	573	80	87	240			
29/84	21	677	637	107	113	279			
JUN 5/84	28	717	680	120	130	305			
JULY 3/84	56	853	810	173	190	382			
31/84	84	933	883	213	223	422			
AUG 31/84	115	1007	953	227	237	480			
SEP 25/84	140	1047	990	243	253	502			
OCT 23/84	168	1093	1040	263	273	530			
NOV 27/84	203	1143	1077	277	293	557			
DEC 19/84	224	1163	1110	290	303	572			
JAN 22/85	259	1197	1133	303	320	585			
MAR 5/85	301	1217	1160	313	333	597			
APR 17/85	344	1250	1190	327	340	618			
MAY 15/85	372	1273	1207	333	350	630			

CREEP DATA REPORT (ASTM C512)

Mix Designation CRA Date of Mixing APRIL 4/84

Specimen Number CRA 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading JULY 4/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 275 με Instantaneous Modulus 35.3 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS - με

Date	Time Loaded -days	CRA-3 LOADED	CRA-4 LOADED	CRA-5 UNLOADED	CRA-6 UNLOADED	CREEP STRAIN-με			
JULY 4/84									
"	0	273	277						
"	5.5hr.	317	317	7	3	37			
5/84	1	363	370	23	23	69			
6/84	2	397	400	27	37	92			
9/84	5								
10/84	6	463	470	43	57	142			
11/84	7	487	497	60	70	152			
18/84	14	557	577	87	93	202			
25/84	21	613	623	110	120	228			
AUG 8/84	35	693	713	127	133	298			
30/84	57	803	833	180	187	360			
SEP 26/84	84	883	917	217	217	408			
OCT 24/84	112	950	983	243	243	449			
NOV 27/84	146	1020	1053	270	270	492			
DEC 19/84	168	1050	1090	287	283	510			
JAN 22/85	202	1097	1137	313	310	531			
FEB 11/85	228								
MAR 5/85	244	1140	1183	327	323	562			
APR 18/85	288	1180	1220	343	340	584			
MAY 24/85	324	1213	1253	357	353	603			
* JUNE 10/85	341	1193	1233	323	320	617			

CREEP DATA REPORT (ASTM C512)

Mix Designation F1A Date of Mixing FEB 14/84

Specimen Number F1A3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 90, Days at 50% R.H. _____

Date of Loading MAY 14/84 Age 90 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 273 με Instantaneous Modulus 35.5 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded -days	F1A-3 LOADED	F1A-4 LOADED	F1A-5 UNLOADED	F1A-6 UNLOADED	CREEP STRAIN-με
MAY 14/84	0	273	273			
"						
15/84	1	320	330	0	0	52
16/84	2	367	370	13	10	84
18/84	4	407	413	20	23	116
22/84	8	437	450	33	37	136
28/84	14	487	503	53	53	169
JUN 4/84	21	540	547	77	73	196
13/84	30	580	593	93	97	219
JULY 10/84	57	683	690	137	133	279
AUG 8/84	86	740	757	157	147	326
SEP 7/84	116	807	817	187	187	352
OCT 2/84	141	850	870	213	207	377
NOV 2/84	172	907	917	233	227	409
26/84	196	933	947	243	237	427
JAN 7/85	238	980	987	267	263	446
23/85	254	997	1007	273	270	458
MAR 22/85	312	1040	1057	293	283	488
MAY 3/85	354	1077	1083	303	300	506
15/85	366	1077	1097	303	300	513

CREEP DATA REPORT (ASTM C512)

Mix Designation F2A Date of Mixing FEB 21/84

Specimen Number F2A 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading MAY 22/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 299 με Instantaneous Modulus 32.5 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded -days	F2A-3 LOADED	F2A-4 LOADED	F2A-5 UNLOADED	F2A-6 UNLOADED	CREEP STRAIN-με
MAY 22/84		297	300			
"	6.5hr.	323	337			
23/84	1	360	370	3	10	60
24/84	2	393	393	13	20	78
25/84	3	417	423	17	20	103
28/84	6	460	470	33	40	130
29/84	7	480	490	53	53	134
JUN 5/84	14	557	553	73	77	182
13/84	22	627	620	97	97	228
19/84	28	663	657	107	113	252
JULY 17/84	56	793	783	163	177	320
AUG 14/84	84	877	867	180	197	385
SEP 11/84	112	947	940	217	237	418
OCT 9/84	140	1000	990	240	260	447
NOV 8/84	170	1047	1037	260	283	472
DEC 17/84	209	1103	1090	280	300	508
FEB 8/85	262	1153	1140	303	320	537
MAR 5/85	287	1170	1163	313	330	547
APR 8/85	321	1203	1193	323	337	570
MAY 14/85	367	1237	1220	337	353	585

CREEP DATA REPORT (ASTM C512)

Mix Designation F3A Date of Mixing FEB 29/84

Specimen Number F3A 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 90, Days at 50% R.H. _____

Date of Loading MAY 29/84 Age 90 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 247 με Instantaneous Modulus 39.4 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAIN-με

Date	Time Loaded -days	F3A-3 LOADED	F3A-4 LOADED	F3A-5 UNLOADED	F3A-6 UNLOADED	CREEP STRAIN-με			
MAY 29/84		253	240						
"	5.5hr.	273	270	7	3	20			
"									
30/84	1	297	297	13	7	41			
31/84	2	317	317	17	13	56			
JUN 1/84	3	333	323	20	17	63			
4/84	6	370	360	30	33	87			
5/84	7	373	363	30	33	90			
13/84	15	427	423	53	53	126			
19/84	21	463	460	63	63	152			
25/84	27	480	483	80	83	154			
JULY 24/84	56	570	573	113	117	208			
AUG 23/84	86	617	617	133	130	239			
SEP 18/84	112	657	653	153	150	257			
OCT 18/84	142	703	700	173	180	279			
NOV 15/84	170	737	727	193	197	291			
DEC 17/84	202	770	757	207	210	309			
JAN 8/85	224	787	777	220	220	316			
FEB 8/85	255	807	797	220	230	331			
MAR 5/85	280	830	813	230	237	342			
APR 9/85	315	853	843	243	250	355			
* JUN 10/85	377	857	840	230	233	371			

CREEP DATA REPORT (ASTM C512)

Mix Designation F4A Date of Mixing MAR 22/84

Specimen Number F4A 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 90, Days at 50% R.H. _____

Date of Loading JUNE 20/84 Age 90 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 237 με Instantaneous Modulus 40.9 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded -days	F4A-3 LOADED	F4A-4 LOADED	F4A-5 UNLOADED	F4A-6 UNLOADED	CREEP STRAIN-με			
JUN 20/84	0	237	237						
21/84	1	277	287	10	0	40			
22/84	2	300	313	23	13	52			
25/84	5	337	350	33	20	80			
26/84	6	353	367	40	23	92			
27/84	7	363	373	40	23	100			
JULY 4/84	14	400	417	60	43	120			
11/84	21	433	443	57	43	151			
18/84	28	443	450	70	50	150			
AUG 15/84	56	513	517	93	70	197			
SEP 12/84	84	570	570	127	103	218			
OCT 10/84	112	620	627	150	127	248			
NOV 7/84	140	657	660	170	147	263			
DEC 17/84	180	703	707	190	167	290			
JAN 22/85	216	733	737	213	183	300			
FEB 11/85	236								
MAR 5/85	258	767	770	227	197	320			
APR 9/85	293	797	800	237	207	340			
MAY 15/85	329	820	823	253	227	345			
* JUN 14/85	359	820	823	223	200	373			
* JULY 10/85	385	837	840	240	213	375			

CREEP DATA REPORT (ASTM C512)

Mix Designation FSA Date of Mixing MAR 27/84

Specimen Number FSA 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading JUNE 26/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 237 με Instantaneous Modulus 41.0 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded - days	FSA-3 LOADED	FSA-4 LOADED	FSA-5 UNLOADED	FSA-6 UNLOADED	CREEP STRAIN-με			
JUN 26/84									
26/84	0	233	240	0	0	0			
26/84	2.5hr.	253	257						
27/84	1	287	280	-3	7	45			
28/84	2	310	300	0	13	62			
29/84	3	323	310	7	13	70			
JULY 3/84	7	377	347	17	37	99			
10/84	14	417	377	17	33	136			
17/84	21	463	410	37	53	155			
24/84	28	503	447	43	67	184			
AUG 28/84	58	573	520	70	93	229			
SEP 18/84	84	627	570	97	120	254			
OCT 18/84	114	683	617	123	153	276			
NOV 15/84	142	730	667	143	173	304			
DEC 11/84	174	760	703	153	183	327			
JAN 22/85	210	793	737	173	210	337			
FEB 15/85	234								
MAR 5/85	252	830	773	190	220	360			
APR 16/85	294	863	807	197	233	384			
MAY 15/85	321	883	827	213	250	387			
*JUN 16/85	353	880	827	193	227	407			
*JULY 10/85	379	897	840	210	240	407			

CREEP DATA REPORT (ASTM C512)

Mix Designation F6A Date of Mixing APRIL 10/84

Specimen Number F6A 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading JULY 10/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 248 με Instantaneous Modulus 39.1 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded -days	F6A-3 LOADED	F6A-4 LOADED	F6A-5 UNLOADED	F6A-6 UNLOADED	CREEP STRAIN-με
JULY10/84						
"	0	253	243			
"	2.4 hr.	283	277	13	17	17
11/84	1	323	300	20	13	47
12/84	2	330	303	27	20	45
13/84	3	350	327	30	20	66
16/84	6					
17/84	7	400	373	50	40	94
24/84	14	457	427	63	60	133
31/84	21	493	467	93	83	144
AUG 9/84	29	523	497	87	73	182
SEP 7/84	59	623	593	140	123	229
OCT 2/84	84	687	643	170	160	252
NOV 2/84	115	740	697	197	183	281
NOV 27/84	140	770	730	210	197	299
JAN 7/85	181	817	777	237	227	317
FEB 8/85	198	840	803	247	237	332
FEB 23/85	228					
MAR 22/85	255	883	840	263	250	357
MAY 3/85	297	917	870	280	270	371
* MAY 24/85	318	927	887	280	270	384
* JULY 10/85	365	943	887	270	263	401

CREEP DATA REPORT (ASTM C512)

Mix Designation F7A Date of Mixing MAY 11/84

Specimen Number F7A 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 90, Days at 50% R.H. _____

Date of Loading AUG. 9/84 Age 90 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 263 με Instantaneous Modulus 36.9 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded -days	F7A-3 LOADED	F7A-4 LOADED	F7A-5 UNLOADED	F7A-6 UNLOADED	CREEP STRAIN-με		
AUG 9/84	0	263	263					
"	6 hr.	287	290	7	3	21		
10/84	1	307	317	13	10	38		
13/84	4	373	393	40	37	82		
14/84	5	393	410	47	47	92		
15/84	6	400	420	47	47	100		
16/84	7	410	433	60	57	100		
23/84	14	483	500	83	80	147		
30/84	21	537	550	107	107	174		
SEP 7/84	29	567	580	123	120	189		
OCT 4/84	56	670	677	177	173	236		
NOV 1/84	84	760	757	213	210	284		
29/84	112	813	817	243	240	311		
JAN 7/85	151	867	867	270	263	338		
FEB 8/85	183	900	903	290	280	354		
APR 9/85	243	970	973	317	310	395		
26/85	260	997	993	333	323	404		
* JUNE 10/85	305	987	987	300	293	428		
* JULY 26/85	351	1027	1027	317	310	451		

CREEP DATA REPORT (ASTM C512)

Mix Designation F8A Date of Mixing APR. 26/84

Specimen Number F-8A-3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading JULY 26/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 252 με Instantaneous Modulus 38.5 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded - days	F8A-3 LOADED	F8A-4 LOADED	F8A-5 UNLOADED	F8A-6 UNLOADED	CREEP STRAIN-με			
JULY 26/84									
26/84	0	257	247						
26/84	4hr	290	293	13	10	23			
27/84	1	323	320	23	23	47			
30/84	4	380	383	30	43	93			
31/84	5	410	407	57	57	100			
AUG. 01/84	6	427	430	60	60	117			
02/84	7	433	443	60	67	123			
09/84	14	510	500	63	60	192			
16/84	21	563	560	93	90	218			
23/84	28	613	603	117	113	241			
SEPT. 20/84	56	737	727	180	173	304			
OCT. 18/84	84	813	807	227	220	335			
NOV. 15/84	112	893	870	253	250	373			
DEC. 17/84	144	947	927	277	273	410			
JAN. 22/85	180	997	973	303	297	433			
MAR. 05/85	222	1047	1020	320	313	465			
APR. 16/85	264	1097	1067	337	340	492			
MAY 15/85	293	1123	1093	350	347	508			
JUNE 10/85	* 319	1107	1067	310	313	524			
JULY 26/85	* 365	1153	1117	340	337	545			

CREEP DATA REPORT (ASTM C512)

Mix Designation F9A Date of Mixing MAY 1/84

Specimen Number F9A 3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 99, Days at 50% R.H. _____

Date of Loading AUG 8/84 Age 99 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 255 με Instantaneous Modulus 38.0 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time loaded -days	F9A-4 LOADED	F9A-5 LOADED	F9M-3 UNLOADED	F9A-6 UNLOADED	CREEP STRAIN-με
AUG 8/84	0	250	260			
	5hr	280	290	7	13	20
9/84	1	317	317	13	20	46
10/84	2	340	350	23	27	65
13/84	5	390	400	43	47	95
14/84	6	403	413	47	47	106
15/84	7	407	417	53	53	104
23/84	15	487	490	83	87	149
31/84	23	533	533	103	107	173
SEP 7/84	30	557	560	117	120	185
OCT 3/84	56	647	647	170	170	222
NOV 2/84	86	723	720	207	210	258
NOV 29/84	112	773	773	233	237	283
JAN 7/85	152	827	817	257	263	307
FEB 9/85	184	860	850	270	270	330
FEB 26/85	200					
MAR 22/85	226	903	890	290	297	348
APR 25/85	260	940	927	310	313	367
*MAY 24/85	289	953	940	310	317	378
*JULY 24/85	352	960	943	303	300	395

CREEP DATA REPORT (ASTM C512)

Mix Designation F10A Date of Mixing JUNE 13/84

Specimen Number F10A3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading SEPT 12/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 264 με Instantaneous Modulus 36.8 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS-με

Date	Time Loaded -days	F10A-3 LOADED	F10A-4 LOADED	F10A-5 UNLOADED	F10A-6 UNLOADED	CREEP STRAIN-με			
SEP 12/84	0	260	267						
"	6 hr.	277	277	-10	-10	24			
13/84	1	293	297	-7	-10	40			
17/84	5	370	343	10	13	82			
18/84	6	397	363	20	20	97			
19/84	7	420	393	33	33	110			
26/84	14	460	420	53	53	124			
OCT 4/84	22	503	467	73	70	150			
10/84	28	533	493	87	87	163			
NOV 7/84	56	633	590	133	130	217			
DEC 17/84	96	717	673	173	177	257			
JAN 7/85	117	753	713	197	197	273			
FEB 8/85	149	797	753	220	213	295			
FEB 27/85	168								
APR 9/85	209	877	837	247	250	345			
APR 24/85	224	903	863	260	263	358			
MAY 24/85	254	920	880	270	270	367			
JUNE 26/85	317	940	917	263	263	402			

CREEP DATA REPORT (ASTM C512)

Mix Designation F11 A Date of Mixing JUNE 19/84

Specimen Number F11A3-6 Nature of Test - Loaded/Unloaded

Curing Regime Days Moist 91, Days at 50% R.H. _____

Date of Loading SEPT. 18/84 Age 91 days, Compressive Strength _____ MPa

Applied Stress 9.70 MPa Stress/Strength Ratio _____

Instantaneous Elastic Strain 262 με Instantaneous Modulus 37.1 GPa

Specific Creep _____ Creep Rate _____

Notes:

MEAN STRAINS - με

Date	Time Loaded - days	F11A-3 LOADED	F11A-4 LOADED	F11A-5 UNLOADED	F11A-6 UNLOADED	CREEP STRAIN - με
SEPT 18/84	0	263	260			
"	6.2 hr.	277	280	13	-17	19
19/84	1					
20/84	2					
21/84	3	367	363	23	3	91
24/84	6	427	427	57	23	126
25/84	7	460	433	60	27	132
OCT 2/84	14	520	510	93	50	182
9/84	21	587	580	123	80	221
18/84	30	630	627	147	97	245
NOV 15/84	58	763	763	207	160	318
DEC 17/84	90	863	867	257	200	375
JAN 8/85	112	913	917	283	227	399
FEB 8/85	143	970	983	300	247	442
MAR 5/85	168	1010	1027	320	270	462
APR 16/85	210	1077	1127	340	293	524
MAY 15/85	239	1120	1167	363	313	544
X JUN 10/85	265	1097	1147	330	277	557
X JULY 10/85	295	1147	1190	360	300	577